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Thinking on Paper: Using Science Notebooks to Increase Active Engagement in the Elementary Science Classroom

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Thinking on Paper

USING SCIENCE NOTEBOOKS TO INCREASE ACTIVE ENGAGEMENT IN THE ELEMENTARY SCIENCE CLASSROOM

Photograph by Zsuzsanna Kilian

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ABSTRACT: The need for scientific literacy is becoming a new standard to which school districts are being held accountable. Student inquiry and the ability to "think like a scientist" will increase the depth at which students understand the natural world and make connections that are critical in strengthening students' scientific literacy. In addition, research has shown that when students were actively engaged in the learning process, they participated more enthusiastically and retained the concepts being taught. Science notebooks help students learn to record and make sense of data and observations about the natural world and come to deeper understanding of scientific processes. *This activity promotes National Science Education Content Standards A and G, and Iowa Teaching Standards 1, 4, 5, and 8.*

Science is more than a body of knowledge. Science is a way of thinking and investigating. One of the major goals of science education is the development of scientific literacy in students. According to the American Association for the Advancement of Science (1993), scientific literacy involves students' ability to determine relevant from irrelevant information, explain and predict scientific events, and link claims to evidence to make scientific arguments. This article discusses how science notebooks can be used to increase elementary students' scientific literacy.

I discuss uses of science notebooks that focus on building science content and process skills in a manner similar to the way scientists work while serving as a context for developing literacy. Students use their notebooks to reflect on their work, engage in collaborative projects, more fluently participate in group discussions, and develop a unique system of recording notes and technical drawings that will aid in their acquisition of scientific knowledge enabling them to make sense of their own learning (Campbell & Fulton, 2003).

Using Science Notebooks

In the Davenport Community School District, Kindergarten through Grade 5 FOSS (Full Option Science System) kits serve as a resource for teaching science. While these kits provide appropriate activities for students, we have reduced the number of FOSS worksheets used by students with the implementation of science notebooks. For each investigation, notebooks are used for writing down the "big idea" or research question, forming questions about the investigation, collecting data, and justifying conclusions/ideas. Diagrams (labeled drawings) are also included in the notebooks providing students with alternatives to writing descriptions when writing might not be a student's strength. Whereas worksheets are easily lost, the science notebook becomes a student-created resource, readily accessible and a product in which students have ownership.

A primary example of how students might use the notebooks during a lesson is evident in the way the notebooks are used in conjunction with the FOSS kit *Structures of Life*. During one of the crayfish investigations, students are asked to draw a diagram of a crayfish in their notebooks and label all the structures of this organism (Figure 1). They are then asked to write how each structure helps the crayfish survive in its habitat. Rather than using the FOSS template for recording observations, our students create their own drawings and labeling systems that are useful for later referral when learning more about the crayfish. Having students create their own system for labeling the crayfish as well as identifying what parts might be important more accurately reflects the decision-making process of scientists. Additionally, having students make their own data collection systems encourages deeper engagement with the content and promotes higher-order thinking.

Of course, students may need some guidance when making their drawings. If students are struggling with how to make the drawing or how to accurately label their drawings, then consider showing a few good examples. Ask them to explain why these examples are good drawings. If students will be recording data in a table, consider having them examine the Nutritional Information table from a food package and ask them why these data are easy to read and understand. When students note that the information is all in rows or in boxes ask, "How can we use that idea to organize our numbers?" These scaffolds are important steps in helping students understand how to better organize their notebooks rather than having them simply follow directions to copy down information.

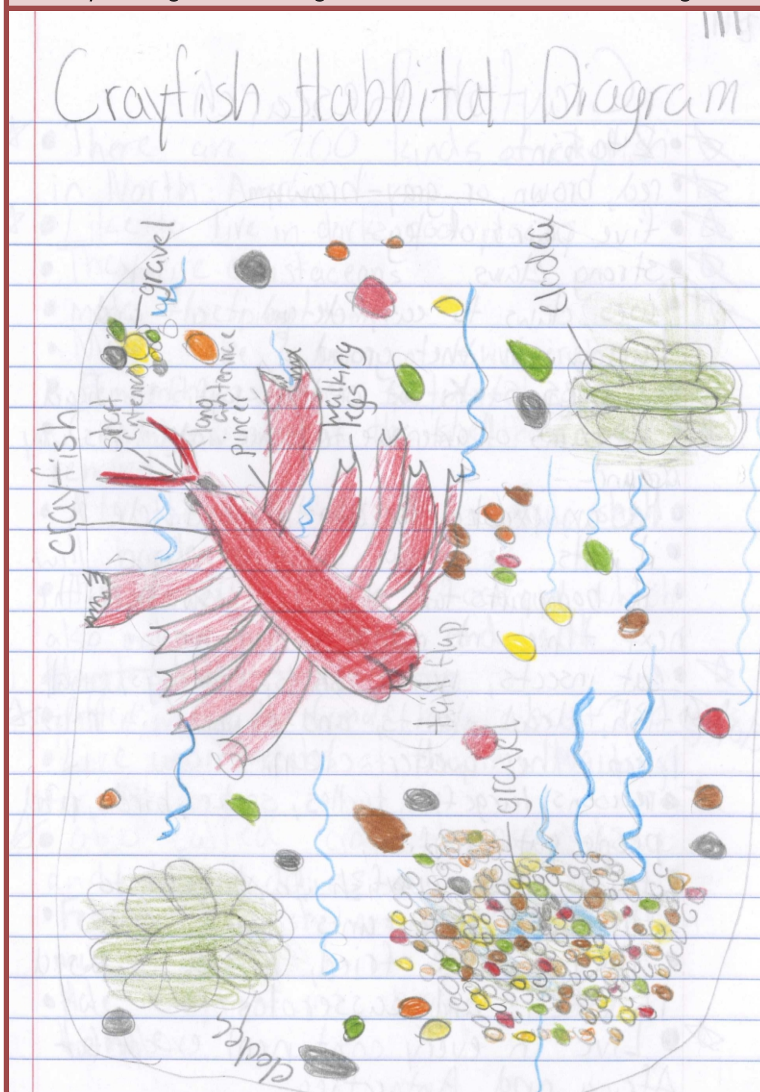
Beyond recording data, science notebooks encourage student questioning and further inquiry. As students engage in conversations about crayfish habitat requirements and territorial behaviors, they are encouraged to write down additional questions that arise during these conversations (Figure 2). As the small group discussions continue, students share their questions with each other and possibly discover they have the same concerns or curiosities as other group members. Whole class discussions can then enrich the learning experience as students confer with each other using the information recorded in the science notebooks.

Many students struggle to articulate their questions and wonderings in writing with clarity. One scaffold for helping students create questions is to provide example prompts. Some possible examples include:

- I wonder how…
- Why does…
- What would happen if…

FIGURE 1

Sample diagram drawing from Structures of Life investigation.



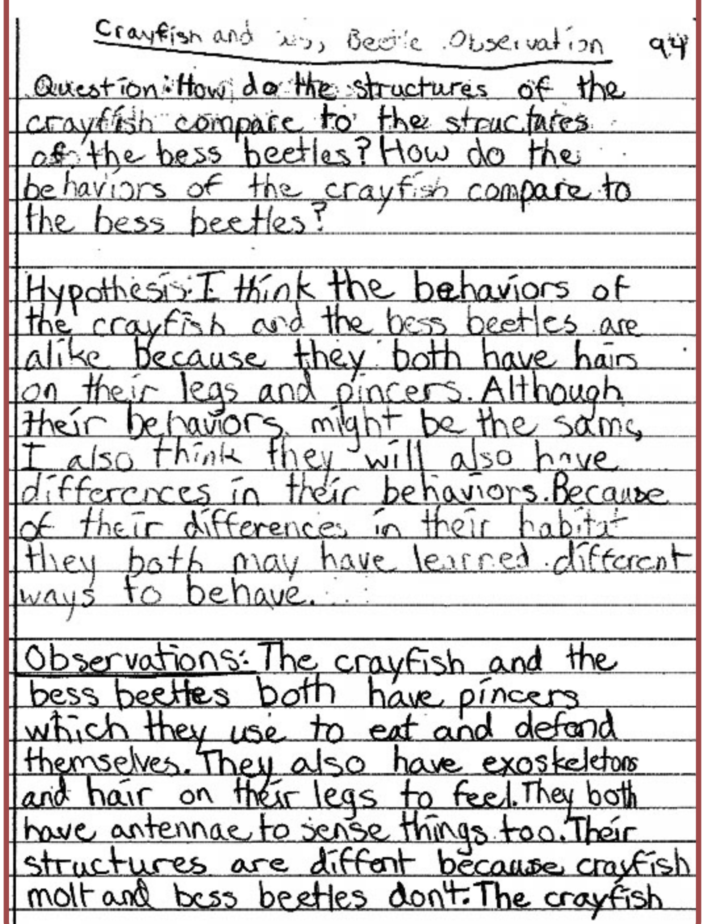
Depending on your students, you may need to provide more extensive prompts. However, leaving the prompts more open-ended can help students get started without doing too much thinking for the students.

As students acquire more information and details about a specific concept, encourage them to reflect on the learning that was recorded in the notebooks and address any misconceptions or conflicting data presented by other groups or classmates. For example, a teacher could ask students to compare their conclusions from a previously completed investigation to their thinking about their current investigation. Asking students to make connections to previous work is important as it helps them develop deep conceptual understanding of science concepts. If students are not making connections across investigations, they may misinterpret the investigations as just-for-fun activities rather than developing deep understandings of science ideas and concepts.

More importantly, teachers must explicitly guide students' reflections. Without teacher guidance, many students would not consider how their previous investigations or thinking might influence their current investigations. These kinds of reflections help students develop connections between science taught in the classroom and a deeper understanding of the natural world. These deep reflections may not be possible without the notebooks providing students with a consistent place in which to record data and evidence that can be analyzed, discussed, and used to communicate findings to each other and the teacher. Essentially, these notebooks aid in student reflection about their learning and simulate how scientists carry out investigations and gather evidence to support their work in an authentic manner.

FIGURE 2

Sample questions written by a student during an observation.


Crayfish and Bess Beetle Observation 9.4

Question: How do the structures of the crayfish compare to the structures of the bess beetles? How do the behaviors of the crayfish compare to the bess beetles?

Hypothesis: I think the behaviors of the crayfish and the bess beetles are alike because they both have hairs on their legs and pincers. Although their behaviors might be the same, I also think they will also have differences in their behaviors. Because of their differences in their habitat they both may have learned different ways to behave.

Observations: The crayfish and the bess beettes both have pincers which they use to eat and defend themselves. They also have exoskeletons and hair on their legs to feel. They both have antennae to sense things too. Their structures are diffent because crayfish molt and bess beetles don't. The crayfish

Using Notebooks Beyond Science Investigations

Many teachers in our district make use of science notebooks. The motivation used to encourage students to record information in science notebooks varies from teacher to teacher. Some teachers incorporate formative assessment strategies in their daily science lessons where students are able to use the information recorded in their notebooks to demonstrate knowledge of a concept or skill. Other teachers allow students to use their notebooks on weekly quizzes or as a review for a quarterly assessment. The more complete and detailed the information is in the notebook, the more accurate the information will be for the student to use for assessments and reviews. This is a highly motivating feature for entering data and information into science notebooks. Notebooks also provide opportunities for teachers to conference with individual students or in small group settings to address misconceptions by asking students targeted questions about information they have written in their notebooks.

Non-fiction writing opportunities in reading and science lend themselves naturally to the use of science notebooks. Students are able to use the information they learn and record in their notebooks to create various writings that have an authentic purpose. The example on the next page was taken from a third grade student during a unit about seeds. The students were able to write in their notebooks during the scheduled time for the reading/writing lesson in class about a lesson they had participated in during science class. Cross-curriculum, non-fiction writing has become another reason to use science notebooks in the elementary classroom.

Implementation Concerns – Scaffolding Students' Notebook Use

Some concerns with implementing science notebooks in the elementary classroom include the amount of time needed for recording information in them, exactly what information should be recorded, how they should "look" according to the teacher, and teachers not using the standard FOSS worksheets for recording and allowing the students to record information in a way that is meaningful to them. Many teachers begin using the science notebooks by simply copying the FOSS worksheets and having the students glue them into the science notebooks and then record information. While this helps with keeping all of the students' work in one place, this strategy does not help students learn how to organize their own work, make their own decisions, or take ownership of their investigations.

Investigating Seeds in Fruit
3rd grade student writing sample from notebook

My investigation was about seeds in fruits. The question was: "How do the properties of seeds compare in different kinds of fruits?" My hypothesis was that I was writing about the size, what color, and what shape. Then I got my fruit. It was a cantaloupe. It was about as big as my head. It was white and green mixed together. It had a lot of lines on the outside. In the inside, on the round parts it was orange. In the middle it looked like groups of seeds. It was all slimy and gooey. I did an estimate and I said I had 150 seeds. I wondered if the seeds would grow more cantaloupes. The seeds were small and looked like pumpkin seeds. The seeds were shaped like a circle and an oval. My friends at my table had fruits too. [My friend's] fruit was a cucumber. She estimated 200 seeds. It was the color of dark green. [Another student's] fruit was an apple. It had 12 sphere shaped seeds. The color was brown with a little darker inside of the seed. [The last person in our group had a] fruit [that] was a lemon. It had 11 seeds. It was hard to find the seeds. The seeds were white. Our seeds were all different sizes and shapes. Some fruits had lots of seeds and some did not. The most important part of this is our science notebook..

Inquiry-based science encourages students to create their own methods for recording data and information into notebooks. However, allowing students to create their own methods of organizing this data can be challenging in the beginning if students have not been previously exposed to this way of learning. Rather than simply eliminating the FOSS worksheets altogether, I suggest showing students the worksheet during the first few investigations and asking how it could help them organize their data and information. In later investigations, ask students to evaluate the FOSS worksheet and elaborate as to what other ways the information they are collecting could be organized. Eventually, instead of providing the students with a FOSS worksheet at the beginning of the investigation ask them how they could record the data or information in an organized manner in their own notebooks. If they experience difficulties in recording this data or information, have them refer to previous investigations and determine how those strategies for recording data and information could be applied to the new investigation. Although this process takes time, the gains in the students' abilities to create and evaluate ways to organize data and information are well worth the effort.

To aid in scaffolding students' use of the notebooks, I highly recommend teachers keep a notebook of their own for modeling purposes. This modeling provides a way for the teacher to demonstrate to students how they should be utilizing their own notebooks. Do not simply have the students copy your own notebook. Instead, ask the students to think about why you set up your notebook the way you did. Ask the students to think about why you chose to write down certain pieces of information. Once the students have seen the teacher model strategies for recording information in a notebook and have been given opportunities to think about the rationale for recording information in their notebooks, a brief explanation or "Think-Aloud" from the teacher will likely help clarify the benefits for recording information in science notebooks. By asking students to justify their thoughts as to why you recorded specific information, you will be able to quickly assess whether or not they understand how and why the use of science notebooks can help increase active engagement and learning during science.

Now It's Your Turn!

Children have a natural sense of curiosity about the world around them. Teachers are in a unique position to help students develop their curiosity through meaningful experiences. However, experiences alone are rarely enough for students to think deeply and make sense of their observations. Science notebooks are a valuable tool to help students organize their ideas, think at a deeper level, and develop scientific literacy.

References

Campbell, B., & Fulton, L. (2003). Science notebooks: Writing about inquiry. Portsmouth, NH: Heinemann.

Kimberly R. Gasaway has over 17 years of experience in K-12 education. This includes 14 years of teaching experience in the areas of math, science and robotics. Kimberly currently is the Science Curriculum and Instructional Specialist, K-12, for the Davenport Community School District. She can be contacted at gasawayk@davenportschools.org.